FOREST PEST LEAFLET 118

# *Balsam Woolly Aphid*

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The balsam woolly aphid (*Adelges piceae* (Ratzeburg)) causes great damage to true fir (*Abies* spp.) forests in some sections of North America. The pest was introduced from Europe and probably first entered Northeastern United States and Southeastern Canada about 1900. Later, it appeared on the west coast (1929) and in Southeastern United States (1956). Infested nursery stock is the presumed source of introduction into these regions.

The aphid is a tiny sucking insect that gets its nourishment from living bark of the main stem and branches. It has tremendous reproductive capacity, and epidemics seemingly occur overnight. Moreover, because North American hosts are so sensitive to attack, the damage seems out of proportion to the insect's size and method of feeding.

Infested true fir forests in both the East and West have been severly attacked by the aphid. In some localities, stands are approaching extinction. To make the situation more ominous, the pest still seems to be spreading.

Because true firs are familiar to most people using the forests, the balsam woolly aphid has considerable significance within the concept of multiple use. True firs are valuable pulp and lumber species, irreplaceable in some land rehabilitation situations, and perhaps the best known, most revered trees in many high-use recreation areas.

## Hosts and Distribution

True firs are the only known hosts of the woolly aphid and few, if any, are resistant to infestations. Judging by the damage done, North American species are most sensitive to attack. European firs, notably European silver fir (*Abies alba* Miller), support large aphid populations yet remain relatively unharmed. Asian firs seem intermediate in sensitiveness; some are damaged and some are not.

Infestations in eastern North America occur on balsam fir (*Abies balsamea* (L.) Mill.) in northeastern New York, through-

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U.S. DEPARTMENT OF AGRICULTURE
Forest Service
July 1970

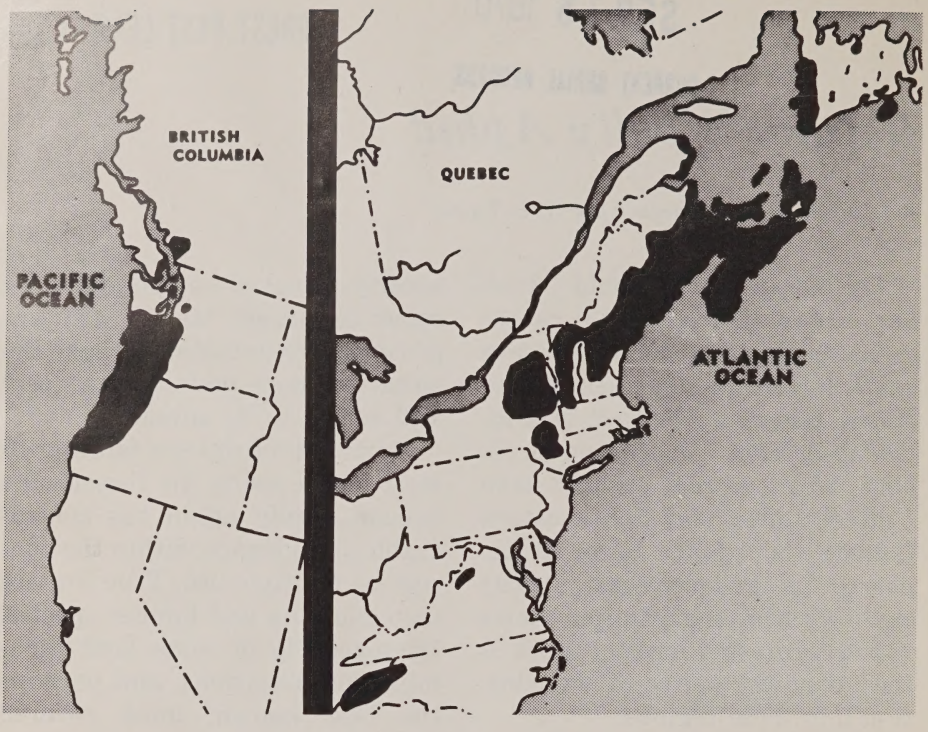


**Figure 1.—Distribution of the balsam woolly aphid in North America.**

out New England and the Canadian Maritime Provinces, and into the Gaspé region of Quebec. Bracted balsam fir (*A. balsamea* var. *phanerolepis* Fern.) and Fraser fir (*A. fraseri* (Pursh) Por.) are infested in the mountainous regions of northern Virginia, western North Carolina, and eastern Tennessee. In the West, some infested exotic trees have been observed in the San Francisco area of California, but the most significant infestations are confined to the western regions of Oregon and Washington and the southwestern corner of British Columbia in Canada. Subalpine fir (*A. lasiocarpa* (Hook.) Nutt.) and Pacific silver fir (*A. amabilis* (Dougl.) Forbes) are infested in the mountainous areas and grand fir (*A. grandis* (Dougl.) Lindl.) in the lowland valleys (fig. 1).

Several other North American fir species in exotic plantings have been reported as being attacked by the wooly aphid, such as white fir (*Abies concolor* (Gord and Glend.) Lindl.), noble fir (*A. procera* Rehd.), Shasta fir (*A. magnifica* var. *shastensis* Lemm.), California red fir (*A. magnifica* A. Murr.), corkbark fir (*A. lasiocarpa* var. *arizonica* (Merriam) Lemm.), and sacred fir (*A. religiosa* Lindley). The first three species have shown signs of resistance in natural stands in Oregon. So far as is known, the other three have never been exposed to the aphid in their natural environment.

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**Figure 2.—Gouting on subalpine fir caused by the baslam woolly aphid.**

## Symptoms of Attack

"Gouting" is a symptom of woolly aphid attack shared by all North American firs. It appears as a stunting of terminal growth with distinct swellings around the buds and branch nodes (fig. 2). The larger "gouts" or swellings occur in the fastest growing parts of the crown and on trees that thave been lightly infested for a long time. Trees with this type of injury decline slowly, sometimes persisting for years. Growth is retarded, and the dead and dying upper stem is often invaded by wood-destroying fungi.

Another, more serious, type of attack is the mass infestation along the main stem (fig. 3). Populations frequently reach densities of 100 to 200 aphids per square inch of bark surface. Symptoms of decline vary somewhat with the tree species infested, but generally the foliage in a dying tree turns yellow, then deep red or brown. This sequence is particularly characteristic of infested balsam, Fraser, and subalpine fir. Stem-infested grand and Pacific silver firs generally

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**Figure 3.—Heavy population of the balsam wooly aphid along the stem of subalpine fir.**

have needle loss, followed by a change in color to a grayish green and, ultimately, death.

Stem-attacked trees often die quickly, sometimes after only 2 to 3 years of heavy infestation. Symptoms of gouting are seldom conspicuous in this type of infestation because of the trees' weakened condition and the short period of infestation.

All sizes of trees are attacked, although trees pole-size and larger seem most susceptible. In the West, stem infestations are most abundant on the best sites; on poorer sites, crown attacks prevail. In New England and the Maritime Provinces of Canada, stem infestations are most abundant in the inland areas, and crown attacks predominate in the coastal zones. Bracted firs are attacked mostly by gout infestations, and Fraser fir is afflicted mostly by stem attacks.

## Effect on Host Trees

Stem and twig injury orginates from localized chemical reaction

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**Figure 4. – Compressionlike wood in irregular outer rings caused by the tree's reaction to infestation by the balsam woolly aphid.**

between the infesting aphid and its host. While feeding, the aphid injects a substance into the bark that affects in some way the hormonal action of the tree and causes abnormal cell division and differentiation in the bark and newly formed wood. Giant parenchyma cells develop in the bark, and the cambium is stimulated to produce an abnormal number of phloem and ray cells. At the same time, an abnormally wide annual ring composed of cells with unusually thick walls is produced in the woody tissue (fig. 4).

The precise relationship between the effects of aphid infestation and declining tree health is unknown. It appears though that the decline in tree vigor due to infestation in the crown stems from loss of foliage and a corresponding decrease in photosynthetic function—buds are inhibited and no new needles replace the old that are naturally shed. Obstruction of the water-conducting tissue seems to be the principal injury associated with stem infestations. But some decline is probably related to obstruction in the phloem tissue, which has an important role in transporting and storing elaborated food.

## The Insect

Balsam woolly aphid populations in North America are composed wholly of females. The adult is tiny (about 1 mm. long), dark purple to black, nearly spherical, and wingless (fig. 5). She has numerous dorsal and lateral pores from which a thick mass of woollike material is produced. In the wool, she lays as many as 248 amber-colored eggs (fig. 6). Reproduction is parthenogenetic; i.e., without mating and fertilization.

An active crawler hatches from the egg. It is about 0.35 mm. long, amber colored, and has red eyespots. The crawler seeks a place to feed, inserts its mouthparts into the bark, and transforms, without molting, into a flattened, wax-fringed resting stage known as the neosistens (plural—neosistentes). Two immature forms closely resembling the adult follow the neosistens. These two forms along with the adult are known collectively as the sistentes (singular—sistens).

A rare stage, known as the progrediens (plural—progredientes), has been observed in Europe and the Maritime Provinces of Canada. In one form it is wingless and in another, winged. The wingless form is very similar to the sistentes. The winged form

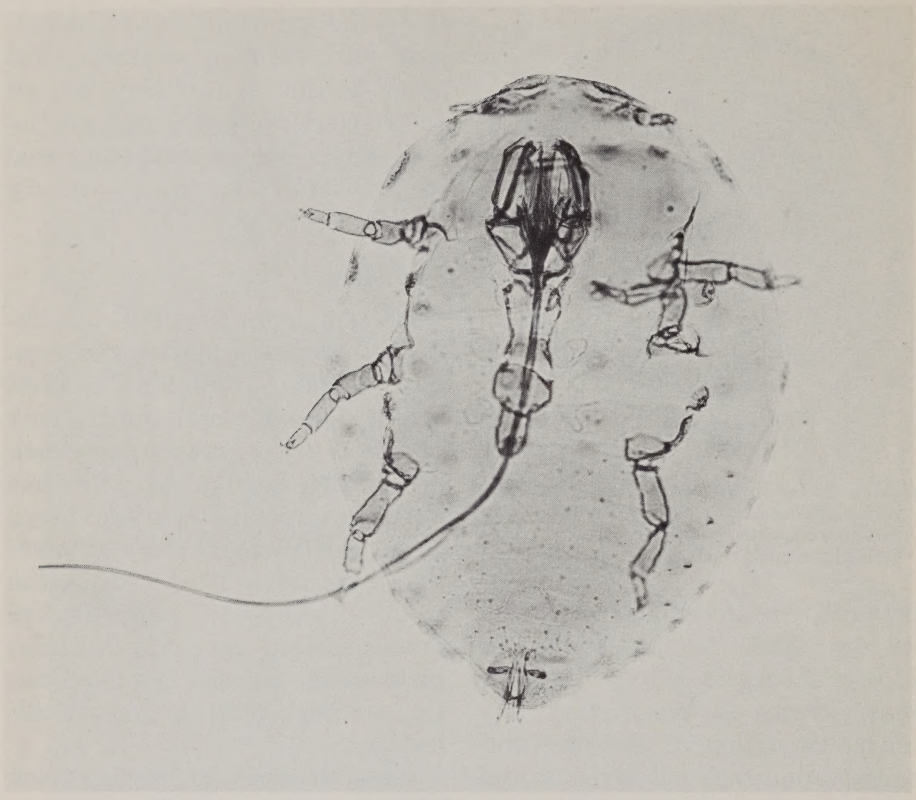

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**Figure 5.—Ventral view of the adult balsam woolly aphid (100X).**

is about 1 mm. long in the adult stage, has conspicuous membranous wings, five-segmented antennae, and generally lacks wax pores.

## Life History and Behavior

The balsam woolly aphid has two to four generations each year, depending upon locality and elevation. Two generations are most common in mountainous areas of the West and throughout New England and the Maritime Provinces of the East. A partial third generation usually develops in North Carolina, and three generations with a partial fourth occur in the lowland areas of Oregon and Washington.

Spring development in the two-generation areas, evidenced by the swelling of the overwintering neosistens stage, begins in late April or early May. By the end of June, most of the aphids are in the adult stage. This is followed by an egg-laying period of about 6 weeks. In warm weather, eggs hatch within a few days, and the crawlers settle on the bark and transform into the resting, neosistens stage. This resting period lasts 2 to 8 weeks. Adults of the second generation become abundant in late September and early October, and egg laying continues into November. Few eggs are

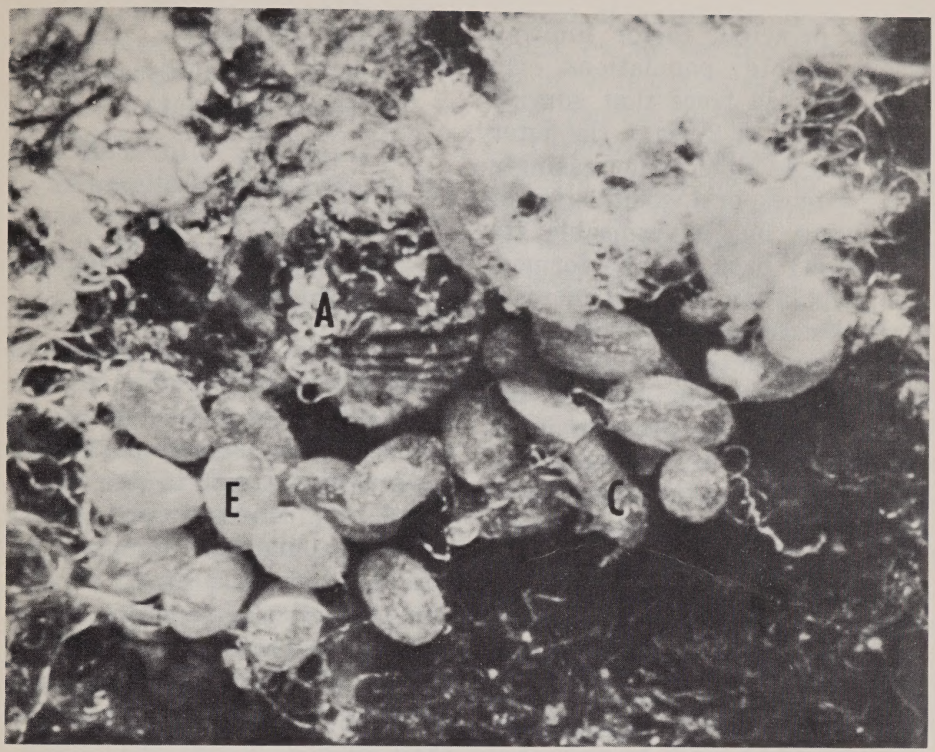


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Figure 6.—Adult balsam woolly aphid (*A*), with clutch of eggs (*E*), crawler (*C*). Wool pushed aside for photographic purposes (65X).

laid or would hatch after about mid-November.

The sequence of development in areas having three and four generations per year is essentially the same as in the two-generation areas. In North Carolina, the insect breaks hibernation about the same time as in New Brunswick, but in developing faster, adults appear about a month earlier than in the northern region. This permits enough time for a partial third generation before winter temperatures halt development. In the low elevations of the Pacific Northwest, the partial fourth generation stems from extremely early development—in some years, neosistentes break hibernation as early as mid-January and the first adults appear in February. However, few eggs hatch before April 1st.

The newly hatched crawler is the only stage capable of directed movement. It disperses and selects feeding sites—most often bark lenticels and other roughened areas of the main stem, around branch and twig nodes, and the base of buds in the crown. Long-range spread is accomplished mainly by wind, though contact with birds and other animals doubtless contributes to natural dispersal.

## Control

*Natural*—The host tree itself

is the principal factor limiting woolly aphid populations. On stem-attacked trees that survive more than 1 or 2 years, the outer bark may be killed in increasingly large patches, or a wound layer of still-living, but impermeable (to the insect) bark may be formed. The population then is increasingly restricted to a smaller and smaller area until most aphids die. Eventually, though, because the tree continues to grow and the protective layer becomes cracked, the tree is subject to reinfestation.

Weather can also materially affect aphid survival, particularly in the northern latitudes. In cold winters, only the aphids below the snowline will survive temperatures of −30° F.

No parasites of the balsam woolly aphid are known, but many predaceous enemies have been noted. Most North American predators, however, are general feeders and unreliable. They do not seem to concentrate in aphid infestations or fluctuate with aphid population levels.

*Biological*—To remedy the lack of effective native predators, several species of insect predators have been introduced into North America from other parts of the world. To date, six species from Europe have become established.

Three are beetles:

*Laricobius erichsonii* (Rosenhauer) Derondontidae)

*Pullus impexus* (Mulsant) (Coccinellidae)

*Aphidecta obliterata* (L.) (Coccinellidae)

and three are flies:

*Aphidoletes thompsoni* Möhn (Cecidomyiidae)

*Cremifania nigrocellulata* (Czerny) (Chamaemyiidae)

*Leucopis obscura* Haliday (Chamaemyiidae).

As yet, none of these predators have achieved detectable control. They appear to feed on stages of aphids, which are unimportant in determining trend in the aphid population. Moreover, expanding aphid populations increase so rapidly, and some North American trees are so sensitive to attack, that predators have little chance of effecting any control before irreversible damage has been done.

*Chemical*—Applying contact insecticides effectively by aerial spraying over large areas appears impossible. The problem is getting the chemical to the insects, often hidden in protective niches in and below the crown and individually protected by their woollike exudation. However, spraying of individual trees from the ground with lindane has proved effective for control. The spray, prepared by mixing 2.5 pints of 10-percent emulsifiable concentrate in each 100 gallons of water, is applied as a bark drench with a hydraulic sprayer in May-June and September-October to control crawlers. Treatment will reduce populations to below the tree-killing level, and some treated trees may remain generally free from aphids for at least 2 years. Spraying is war-

ranted only in accessible areas supporting relatively high-value trees.

**Caution:**

Pesticides used improperly can be injurious to man, animals, and plants. Store pesticides in original containers under lock and key—out of reach of children and animals.

Lindane is poisonous. Handle it with care. Follow the directions and all precautions on the container label. Store away from all foods. Improper use and disposal of unused quantities of lindane can be dangerous to humans, domestic animals, desirable plants and pollinating insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water supplies or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S. Department of Agriculture, consult your county agricultural agent or State Extension specialist to be sure the intended use is still registered.

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